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Description

Adhesive tape for detecting unauthorized broaching of a package

The invention relates to an adhesive tape having a multilayer composite backing based on coextruded, oriented polypropylene which is coated on one side with adhesive composition for use to detect unauthorized broaching of a package.

Theft, product piracy and blackmail of, for example, food groups and trading chains are leading to ever greater economic losses and damage. The use of security systems and security closures for protecting against concealed broaching of goods and the associated possibility of manipulation of the contents is therefore of increasing importance.

Security systems for detecting unauthorized broaching are known and are described in a large number of patents. Security labels are of particular significance in this context. For example, US 4,184,701 describes security labels which are composed of a plurality of ink layers and/or release layers and which as a result exhibit little adhesion of the product layers to one another. In combination with a strongly adhering adhesive composition, such layers separate from one another irreversibly, thereby indicating the broaching of the package.

Furthermore, DE 34 31 239 A1, for example, describes the use of security labels for detecting the unauthorized broaching of a package, said labels comprising a backing material of low tear propagation resistance. In combination with a strongly adhering adhesive composition, the security label is destroyed irreversibly by removal and thus indicates the attempted broaching.

The security label has a lower, first adhesive layer, which is to be detached from a backing and to be applied to the packaging, and is located on the bottom side of a first

label material on whose top side there is applied – via a second adhesive layer – a second label material. The extent of the bond strength of the first adhesive layer between the packaging and the first label material is different than the extent of the bond strength of the second adhesive layer between the first label material and the second label material.

Adhesive packaging tapes for detecting the unauthorized broaching of packaging cartons and other packaging forms are likewise known. For example, EP 0 404 402 A2 and US 4,876,123 describe multilayer carton sealing tapes which in the case of an attempted broaching ensure a transfer of lettering to the packaging surface and thus constitute a securement against broaching. However, this necessitates a bond area which is relatively large and at the same time planar.

When security labels are used for securement against broaching, it is necessary to use an appropriate release paper in order to enable security labels to be applied by machine. The use of the necessary release paper results in an unfavorably high level of complexity associated with the handling of security labels, the production of large amounts of release paper as a waste product from the application of the labels, and a very low level of flexibility in terms of adapting the security closure to the respective packaging system or to the respective system of broaching the packaging. Owing to the fixed size and structure of the label, one particular type of security label can be used only for one particular packaging.

In the case of security labels and of the known adhesive carton sealing tapes for product securement, the multilayer product structure and the use of ink layers and release layers means that complex and laborious production concepts are necessary for the production of such security systems. When these adhesive tapes are used for product securement, for the bonding of complex product closures and/or complicated consumer products, the structure of the products means the detection of unauthorized broaching is unsatisfactory.

The shrink films (sleeves) which may likewise be used for detecting unauthorized broaching exhibit disadvantages in terms of a lack – in some cases – of individualization and in terms of very high material consumption.

One possibility for avoiding a multilayer product structure and, with it, high product complexity is the use of multilayer composite films based on polypropylene, produced by means of coextrusion.

Extrusion is regarded as economically the most important method of plastics processing. With the aid of coextrusion it is possible to produce multilayer films based on thermoplastics and, by way of the chemical and structural composition of the individual layers, to control their cohesion or bonding to one another.

In the sector of the packaging industry, two-layer and three-layer films are of importance. Thus it is known that films comprising non-heat-sealable, coextruded, high crystalline polypropylene layers exhibit a weak bond of the film layers to one another. By using polypropylene layers differing in their degree of crystallinity, and/or by using film layers comprising copolymers such as polypropylene-ethylene, for example, it is possible to vary the bond between the film layers. In this way, it is possible to adjust the cleavage strength of the polypropylene-based composite film and to adapt it to the bond strength of the adhesive composition.

Multilayer composite films may be produced by way of flat film extrusion. An overview of the method of flat film extrusion, and of the production of composite films (coextrusion), is contained, for example, in the article „Herstellen von Verbundfolien durch Extrusionsbeschichtung und Extrusionskaschierung" [Production of composite films by extrusion coating and extrusion laminating] (J. W. Hoff in „Extrudierte Feinfolien und Verbundfolien", VDI Verlag, Düsseldorf (DE).

When multilayer coextruded films are used, the nature of the longitudinal cutting process employed is important for the tensile strength and elongation at break of the product. The cut-edge quality resulting from the choice of longitudinal cutting process employed may produce either a sharp cut edge or a rough cut edge, which greatly influences the tensile strength and elongation at break of the longitudinally cut films.

It is an object of the present invention to specify an adhesive tape which on removal from the surface of the packaging is destroyed and undergoes irreversible self-division or destruction, and which renders reattachment in the original condition impossible, so that

there is perceptible evidence of manipulations of quantitative or qualitative type on the packaged product.

This object is achieved by means of an adhesive tape as specified in the main claim. The subclaims relate to advantageous developments of the subject matter of the invention and to advantageous applications of the adhesive tape.

The invention accordingly provides an adhesive tape comprising a composite backing based on an oriented, coextruded, at least two-layer polypropylene film whose one side is provided with an adhesive composition and whose film layers have a low release force with respect to one another.

Backings based on a biaxially oriented, multilayer, coextruded composite film based on polypropylene are used, as already stated above, as packaging materials. When the coextruded films are used to produce the adhesive tapes of the invention, the overall thicknesses are in particular from 15 to 120 μm, preferably from 20 to 50 μm.

It has also been found advantageous for the thicknesses of the outer film layers to be in particular between 2 and 10 μm, preferably between 3 and 5 μm.

The backing of the adhesive tapes of the invention based on biaxially oriented coextruded polypropylene comprises two or more layers. Particular preference for producing the adhesive tapes of the invention is given to three-layer films based on biaxially oriented, coextruded polypropylene, the film layers, which differ in crystallinity or in composition (polypropylene-ethylene copolymers) being combined in such a way that the resulting bond between the layers is low.

Furthermore, preference for producing the adhesive tapes of the invention is given to biaxially oriented, multilayer coextruded films based on polypropylene having a draw ratio in the longitudinal (machine) direction (MD) of between 1:4 and 1:9, preferably between 1:4.8 and 1:6, and a draw ratio in the transverse (cross) direction (CD) of between 1:4 and 1:9, preferably between 1:4.8 and 1:8.5.

The moduli of elasticity achieved in the machine direction, measured at 10% elongation in accordance with ASTM D882, are usually between 1000 and 4000 N/mm^2, preferably between 1500 and 3000 N/mm^2

The moduli of elasticity achieved in the cross direction are likewise between 1000 and 4000 N/mm², preferably between 1500 and 3000 N/mm².

In one preferred embodiment of the adhesive tape, the adhesion of the adhesive composition to the thermoplastic film based on oriented, coextruded polypropylene is improved by means of corona treatment or flame pretreatment, since the surfaces of the polyolefin-based film in particular may be treated by these widely known techniques, such as corona pretreatment and flame pretreatment. The techniques of surface treatment are reviewed, for example, in Surface pretreatment of plastics for adhesive bonding (A. Kruse; G. Krüger, A. Baalmann and O. D. Hennemann; J. Adhesion Sci. Technol., Vol 9, No 12, pp 1611-1621 (1995)).

In another advantageous embodiment of the adhesive tape, a layer comprising a primer is applied between the polypropylene film and the adhesive layer.

In another advantageous embodiment of the adhesive tape, the side of the polypropylene film opposite the adhesive composition carries a coating, in particular a release coating.

Release coatings on the film surface opposite the adhesive composition are in widespread use in the adhesive tape industry. An overview of release coating systems based on silicone and their use in the field of pressure sensitive adhesives is given in Silicone Release coating (D. Jones, Y. A. Peters in Handbook of Pressure Sensitive Adhesive Technology, Third Edition, edited by Donatas Satas, Van Reinhold New York. pp. 652-683).

The use of rear-face release coatings brings about easy and uniform unwinding of the adhesive tapes. Release coatings based on solventborne carbamate systems and on silicone-based systems are used in particular in this context.

Release coatings based on silicone systems are particularly suitable as release coatings of the adhesive tapes of the invention. As the release coating it is preferred to use UV-curing silicone systems on a 100% basis, although solventborne silicone systems may likewise be used as release coating for the adhesive tapes of the invention.

The application rate of the release coating to the backing material is preferably from 0.1 to 3 g/m^2. In a further particularly preferred embodiment, the layer application rate of the release coating is from 0.2 to 1.5 g/m^2.

Adhesives which may be used include essentially all known adhesive compositions having high bond strength to the adhesion substrate that is to be packaged.
The adhesive composition of the adhesive tape of the invention may comprise an adhesive composition based on solventborne natural rubber and acrylate adhesive compositions. Preference is given to adhesive compositions based on acrylate dispersions, particular preference to adhesive compositions based on styrene-isoprene-styrene block copolymers. These adhesive composition technologies are known and are used in the adhesive tape industry.

The application rate of the adhesive composition to the backing material is preferably from 15 to 60 g/m^2. In a further, preferred embodiment, the layer application rate is from 20 to 30 g/m^2.

The adhesive tapes may be produced by known methods. An overview of customary production methods is given, for example, in Coating Equipment, Donatas Satas in Handbook of Pressure Sensitive Adhesive Technology, second edition, edited by Donatas Satas, Van Nostrand Reinhold New York pp. 767-808. The known processes for drying and cutting adhesive tapes may likewise be found in the Handbook of Pressure Sensitive Adhesive Technology, pages 809-874.
Furthermore, the adhesive tapes of the invention may be printed by means of customary methods.

The longitudinal cutting method used for the adhesive tapes of the invention is the crush cut method, which by means of a rotary cutting knife subject to an applied pressure force, and a counterpressure cylinder, separates the adhesive tape lying in between in the machine direction of the adhesive tape web.
The rotary cutting knife may be designed in such a way, by means of different geometries of the cutter and different surface roughnesses on the cutter flanks, that the cut-edge roughness of the cut adhesive tape is influenced.
The cut-edge roughness has a direct influence on the tensile strength of the cut adhesive tape, i.e., the rougher the cut edge, the lower the tensile strength of the adhesive tape.

The reduction in tensile strength may be used to ensure that an adhesive tape, once applied, can no longer be removed from the bonded substrate without destruction.

Through the use of specifically suitable cutting variants, therefore, it is possible to increase considerably the security effect of adhesive tapes for detecting the unauthorized broaching of a package and to broaden the use of such products.

Preferably, therefore, the edges of the polypropylene film have a serrated cut.

Finally, the concept of the invention also embraces the use of an adhesive tape of the invention on packaging for detecting the unauthorized broaching thereof by virtue of the fact that on removal from the surface of a package the adhesive tape is irreversibly destroyed and clearly indicates an attempted broaching by tearing or splitting in the thickness direction owing to the low tear propagation resistance.

Indeed, the adhesive tape of the invention is suitable for use as a security closure for clear indication of an unauthorized attempted broaching, or of a broaching, for a large number of valuable and/or sensitive goods. An important field of application here is the securement of a wide variety of consumer goods against theft, falsification of the contents, and protection against pirate copies. The unnoticed broaching, theft and falsification of sensitive goods is prevented by the use of the adhesive tapes of the invention.

Relevant packaging forms include folded boxes, bottles and tubes with screw and pressure closures, shampoo bottles, folded boxes and plastic containers.
Suitable surfaces for the packaging material include paper, cardboard, glass, polypropylene, polystyrene, polyvinyl chloride and steel.

Applications in the office sector, in the packaging of medical and pharmaceutical products, the securement of cosmetics and bodycare articles and of foodstuffs and luxury consumables by means of a security closure are possible. Also possible is application for securing electronic and electrical appliances.

By using an adhesive tape as a security closure to protect against unauthorized broaching, it becomes unnecessary to use a release paper as is required when using

security labels. This represents a considerable cost saving and reduces the complexity and greatly reduces the resulting amount of waste. Furthermore, through the use of an adhesive tape for packaging and/or securing products, the flexibility of the types of packaging and types of closure that may be used is increased. As a result of easy unwinding during manual and mechanical application to packaging, the size of the security closure may be varied without problems and adapted to the packaging.

If an attempt is made to remove an adhesive strip of the adhesive tape of the invention from the packaging, then, owing to the bond strength of the security closure being greater than the strength of the backing, the backing will undergo internal splitting and/or irreversible destruction as a result of the low tear resistance and the attempted broaching will be clearly and distinctly indicated. This effect may be enhanced by the use of specific cutting modifications.

Furthermore, it is intended that the novel adhesive tape will unwind easily and exhibit a good bond between adhesive composition and backing film.

The intention of the text below is to illustrate the invention with reference to an example without wishing to restrict the invention unnecessarily.

Example

a: Film a

Film a: Film for the adhesive tapes of the invention

A biaxially oriented, coextruded film based on polypropylene is used, from Radici.

Film thickness:	38 μm
Identification:	Radil EWL
Company/manufacturer:	Radici
Elongation at break, MD:	120%
Elongation at break, CD:	30%

Radil EWL film is a biaxially oriented, coextruded, white three-layer film based on polypropylene and includes the characteristic feature that the bond between the layers is weak. The film is printable.

Film b: Film for reference sample

A biaxially oriented film based on polypropylene was used, from Radici.

Film thickness:	25 μm
Identification:	Radil T
Company/manufacturer:	Radici
Elongation at break, MD:	125%
Elongation at break, CD:	50%

For both films a and b, the opposite surface of the film, that not coated with adhesive composition, was provided with a rear-side coating with the aid of the customary technologies, prior to coating.

The surface of the film that was coated with adhesive composition was corona treated prior to coating. The surface energy was > 42mN/m.

b: Adhesive compositions used

An adhesive composition based on an aqueous acrylate dispersion was used to produce the adhesive tapes of the invention and the reference sample.

c: Application of the adhesive composition

The coating of films a and b with the adhesive composition was carried out using a wire-wound coating bar. The coating bar and the coating rate were adjusted so that after drying the coated film a mass application of approximately 25 g/m^2 is measured. Coating was carried out on a pilot-scale coating unit with a working width of 500 mm at a coating rate of 10 m/min. Downstream of the coating station with wire-wound coating bar applicator unit there was a drying tunnel which was operated with hot air (approximately

100 °C). The coated film was converted in a width of 19 mm as described in d. The security effect was determined following storage at 23°C for two days.

d: Cutting of the adhesive-coated film web

The longitudinal cutting of the film web coated with adhesive composition (films a and b) was done using rotary crush cutting knives which in terms of their cutting geometry are configured as zig-zag knives.

Zig-zag knife	0.2 mm
Number of teeth:	604
Cutting phase angle:	90°
Tooth width:	0.2 mm
Cut-face width:	< 0.05 mm

Figures 1 and 2 show the crush cutting knife 1 which was used. The knife 1 has 604 teeth 2. The cutting phase angle α is 90°. The tooth width A is 0.2 mm, the cut-face width B is less than 0.05 mm.

e: Adhesion substrates for testing the security effect

e1: Polyethylene: polyethylene sheets from Thyssen, Hamburg Identification A27120; 50x200 mm; thickness 3 mm

e2: Polystyrene: polystyrene sheets from Thyssen, Hamburg Identification A27123; 50x200 mm; thickness 3 mm

e3: Polyvinyl chloride: polyvinyl chloride sheets from Thyssen, Hamburg Identification A27126; Kömadur UPVC; 50x200 mm; thickness 3 mm

e4: Glass: glass sheets from Glaserei Dietrich, Hamburg; 50x200 mm, thickness 4,

e5: Steel: steel plates from Thyssen Stahl, to DIN EN 10088-2, steel type 1.4301; roughness Ra: ab = 0.05 μm

e6: Paper (standard typewriter paper)

f: Results

To determine the security effect, the adhesive tapes produced in c were examined and compared with a reference sample. To characterize the security effect on different adhesion substrates, adhesive strips (5x1 cm) of the adhesive tapes and of the reference sample were bonded to the surfaces specified in e and were pressed on using a steel roller weighing 2 kg (which was rolled over the bonds twice). Following a waiting time of 24 hours at 23°C, an attempt was made by hand to see to what extent the adhesive strips could be peeled or removed without destruction. In the course of these attempts, use was also made of technical auxiliary means, such as scissors or knives, for example.

Reference sample:
Adhesive composition based on an aqueous acrylate dispersion.
Backing based on a biaxially oriented polypropylene film (film b)
The reference sample was produced as described in c.

Adhesive strips resulting from adhesive tapes of the invention (film a):

Adhesion substrate	Nondestructive removal possible from the adhesion substrate described in e
Polyethylene	No
Polystyrene	No
Glass	No
Steel	No

Adhesive strips resulting from reference adhesive tape (film b):

Adhesion substrate	Nondestructive removal possible from the adhesion substrate described in e
Polyethylene	Yes
Polystyrene	Yes
Glass	Yes
Steel	Yes